

## V REVIEW OF STATISTICAL POWER

The power of a statistical measure is defined as the probability of a significant observation *given* that an effect hypothesis ( $H_1$ ) is true. Define the value of a dependent variable as  $X$ . Then, given that the null hypothesis ( $H_0$ ) is true, a significant observation,  $x$ , is defined as one in which the probability of observing

$$x \geq \mu_0 + 1.645\sigma_0,$$

where  $\mu_0$  and  $\sigma_0$  are the mean and standard deviation of the parent  $H_0$  distribution, is less than or equal to 0.05.

Figure 3 shows these definitions in graphical form under the assumption of normality. The  $Z$ -Score is a normalized representation of the dependent variable and is given by:

$$z = \frac{(x - \mu_0)}{\sigma_0},$$

where  $x$  is the value of the dependent variable and  $\mu_0$  and  $\sigma_0$  are the mean and standard deviation, respectively, of the parent distribution under  $H_0$ , and  $z_c$  is the minimum value (i.e., 1.645) required for significance (one-tailed). The mean of  $z$  under  $H_0$  is zero. The mean and standard deviation of  $z$  under  $H_1$  are  $\mu_{AC}$  and  $\sigma_{AC}$ , respectively.

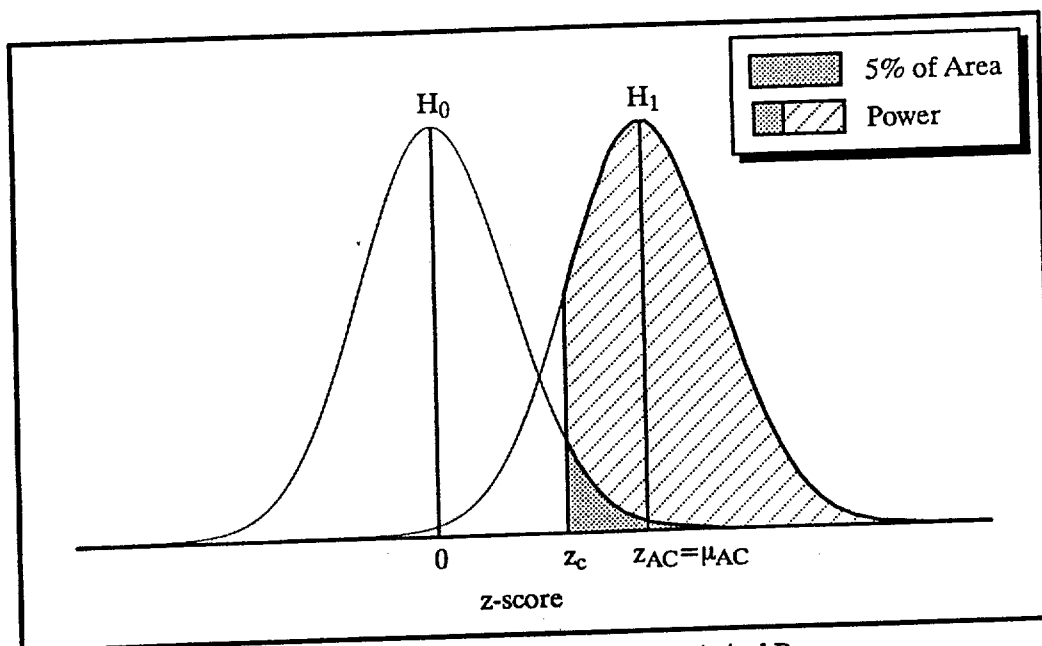


Figure 3. Normal Representation of Statistical Power

In general the effect size,  $\epsilon$ , may be defined as:

$$\epsilon = \frac{z}{\sqrt{n}}, \quad (3)$$

where  $n$  is the sample size. Let  $\epsilon_{AC}$  be the empirically derived effect size for anomalous cognition (AC). Then  $z_{AC} = \mu_{AC}$  in Figure 3 is computed from Equation 3. From Figure 3 we see that power is defined by:

$$\text{Power} = \frac{1}{\sigma_{AC}\sqrt{2\pi}} \int_{z_c}^{\infty} e^{-0.5\left(\frac{\xi - \mu_{AC}}{\sigma_{AC}}\right)^2} d\xi. \quad (4)$$

Let

$$z = \frac{\xi - \mu_{AC}}{\sigma_{AC}}.$$

Then Equation 4 becomes

$$\text{Power} = \frac{1}{\sqrt{2\pi}} \int_{z'_c}^{\infty} e^{-0.5z^2} dz, \quad \text{where } z'_c = \frac{z_c - \mu_{AC}}{\sigma_{AC}}. \quad (5)$$

For planning purposes, it is convenient to invert Equation 5 to determine the number of trials that are necessary to achieve a given power under the  $H_1$  hypothesis. If we define  $z(P)$  to be the  $z$ -score associated with a power,  $P$ , then the number of trials required is given by:

$$n = \frac{4z^2(P)}{\epsilon_{AC}^2}, \quad (6)$$

where  $\epsilon_{AC}$  is the estimated mean value for the effect size under  $H_1$ . Figure 4 shows the power, calculated from Equation 5, for various effect sizes for  $z_c = 1.645$ .

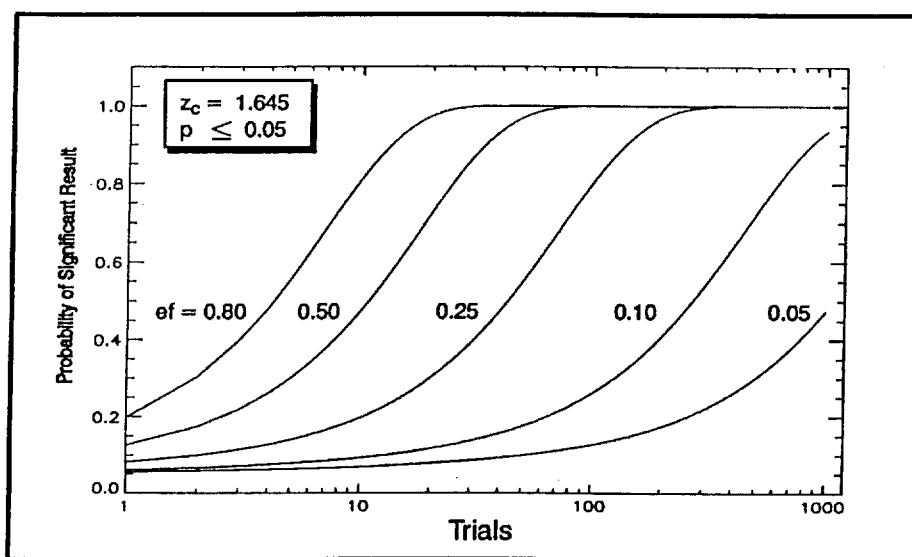


Figure 4. Statistical Power for Various Effect Sizes